Geologic and Hydrologic Basis for Concerns With Mixed Use Development of Whetstone Springs Parcel

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Mixed use development of the Whetstone Springs parcel raises a number of concerns about possible negative and irreversible geologic and groundwater impacts on Kartchner Caverns. The Whetstone Springs parcel is located in the southeast quarter and the south half of the southeast quarter of the northeast quarter of Section 24 T18S R19E, immediately adjacent to Kartchner Caverns on its northwest boundary.

Kartchner Caverns is developed in the Escabrosa Limestone in a fault-bounded block of Pre-Cambrian and Paleozoic metamorphic and sedimentary rocks. This block is known as the Kartchner Block.[1] The Kartchner Block extends out of the park on at least the north and west sides and possibly to the south as well. Geologic mapping shows that most of the property proposed for rezoning is on the Kartchner Block.[2]

The Kartchner Block contains an aquifer that is one of the major sources for water for the cave.[3] The Kartchner Block is extensively cut with faults and fractures that may

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[1] The development of Kartchner Caverns in the Escabrosa Limestone and the nature of the Kartchner Block as a fault-bounded block is discussed in Buecher and Hill (1999), Hill (1999), Jagnow (1999), and Thomson (1990).

[2] Geologic mapping by Creasey (1967) provides the best estimate of the minimum extent of the Kartchner Block (see accompanying map 1). Creasey (1967) shows the block extending across most of the SE Quarter of Section 24, T18S, R19E. Reynolds (1988, as digitized by the Arizona Land Resources Information System) interprets the block to be somewhat larger, and it also shows that much of the area proposed for rezoning is on the block (see accompanying map 2).

[3] Graf (1999) describes the hydrogeology of the park and identifies the distinct aquifer in the Kartchner Block. He also identifies the Kartchner Block aquifer as a major source of water in the cave.

increase groundwater connectivity through the block.[4] Because the parcel proposed for rezoning and Kartchner Caverns are both in the Kartchner Block, they share the Kartchner Block aquifer. This results in the strong possibility that development or activity on the parcel proposed for rezoning can adversely affect Kartchner Caverns through the shared groundwater system.[5]

Two classes of groundwater-linked impact are of particular concern: (1) lowering of the water table in the Kartchner Block aquifer and (2) contamination. Lowering of the water table in the Kartchner Block could occur in either of two ways. If the development put in a well that pumped water out of the aquifer, that would lower the water table in the aquifer. Another way development could lower the water table would be by reducing infiltration that recharges the aquifer. This could occur by increase in impervious cover (paving or building areas). It is also possible that changing the flow of McGrew Springs could reduce recharging infiltration.[6]

Lowering of the water table in the Kartchner Block could have devastating effects on Kartchner Caverns. The cave is dependent on flooding from the aquifer for much of its moisture. A reduced water table would likely result in a lower flood frequency in the cave. This would mean a reduction in the total moisture available in the cave. The result would be drying of the cave and it changing from a "living" cave into a "dead" one. This would result in the loss of the most important and unique features of the cave. Drying might also affect the suitability of the cave for the bat colony and the ecosystem it supports.[7]

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[4] Jagnow (1999) and Thomson (1990) map some of the better-characterized faults in the Kartchner Block within the park. Thomson (1990) shows a number of faults extending north out of the park into the area proposed for rezoning. Jagnow (1999, p. 18) notes that "the down-dropped block that contains Kartchner Caverns has been broken by thousands of small displacement faults." Casavant (2001, personal communication) indicates that based on mapping that he has had students doing on the park, there are many more minor faults than are shown in published maps. Faults may provide good conduits for groundwater flow. That this is the case in the Kartchner Block is supported by the fact that several of Kartchner Caverns' passages are developed along faults (because of concentration of groundwater flow).

[5] That cave systems can be adversely affected by offsite activities in areas sharing the same aquifer is well documented. Threats to the groundwater systems of caves are among the most significant hazards to most caves. Elliott (2000) describes numerous examples. Gillieson (1996) also provides an introduction to the subject.

[6] The water level in the Kartchner Block is a balance between the water being removed from the aquifer (through evaporation in the cave, pumping from potential wells in the Block, water flowing into the San Pedro aquifer), and water entering the aquifer (through infiltration from overlying areas and infiltration from washes over the aquifer). Development activities can affect either portion of this balance. In the semi-arid climate of southeastern Arizona, there is little excess water to compensate for changes in either sources or outflows. The relationship between McGrew Springs and the Kartchner Block has not been adequately characterized.

[7] Buecher (1999) details the very small difference between the amounts of water the cave receives and that which it loses. He notes how small the margin for additional loss is. Under the natural conditions, even a succession of dry years could begin drying. If the amount of water under natural conditions were further

Contamination of the aquifer could occur in a number of ways related to the development of the parcel proposed for development. If facilities, such as on-site waste treatment facilities, are on the Block, any malfunction of the plant (or incomplete treatment) could result in sewage entering the aquifer. Other sources for contamination would include non-point-source run-off from roads, driveways, lawns, and buildings. This type of run-off often contains contaminants such as gasoline, oil, anti-freeze, fertilizers, and pesticides. Swimming pools and spas use a variety of chemicals that could be problematic if they made it into the aquifer. The presence of garbage will also increase the possibility that bacterial contamination could occur in the aquifer.

Contamination in the aquifer could catastrophically affect the cave. There is no solid information on flow paths within the Kartchner Block. The contamination could show up in the cave with little or no warning or reduction. In the worst case, sewage contamination could force closure for health reasons. If the contaminant was gasoline, dangerous, flammable vapors in the cave could be the result. Other contaminants could produce devastating changes as well.[8] The complex nature of aquifers like the Kratchner Block aquifer means that it is almost impossible to block the flow of contaminants once introduced. Indeed, contamination of the cave might be the first indication that the aquifer has been contaminated. Unfortunately, it is also almost impossible to remove the contamination once it has occurred and the damage may be done, even if contamination can be later removed. Development in the parcel proposed for rezoning would also complicate the effort to protect the cave from contamination by foams and retardants used in forest fire fighting.[9]

Until the Kartchner Block aquifer is better understood, in terms of such parameters as connectivity, flow paths and flow directions, it would be premature to rezone a portion of the Block for development. Such development could have disastrous consequences for Kartchner Caverns and for the State Park.

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reduced through either pumping of the aquifer or loss of some of its recharge, the cave would be in serious danger of drying out.

[8] Karst aquifers (especially highly faulted ones such as the Kartchner Block aquifer) can allow rapid passage of contaminants with little attenuation or dilution. White (1989, p. 4) makes the following point concerning karst aquifers: "… if the pollutants make their way into an open conduit, they can be transmitted for very long distances with relatively little dilution and very little dispersion." Gillieson (1996) also discusses the issue.

[9] We have been discussing ways to reduce the possibility that foam will be used in the area in such a way as to potentially contaminate the cave. However, the decision to use foam is closely integrated with the potential for loss of property. If the parcel being discussed were developed, it could possibly force the use of foam in areas that would affect the cave, if a fire occurred in the area.

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